Space Weather Technical Forecast

Issued on Sunday, 20 February 2022 at 12:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/Minor Geomagnetic Storms Day 1 (20 Feb), slowly declining. Slight chance throughout of M-class flares. Chance of Active fluence Day 3 (22 Feb) onward.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low over the past 24 hours, with two C-flares from over the NE limb, the largest of which was C5.1 at 20/0407 UTC. These are perhaps from returning ex-2938 which was a likely source of a notable far-sided flare and CME on the 15th. There are 3 Earth-sided sunspot regions, however these are all small and simple at the present time. A fourth region is rotating onto the NE limb, likely ex-2936, but this can't yet be analysed. There was a filament eruption in the southeast disc, which has produced a CME. This is expected to miss Earth. No other Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, showed the arrival of a high speed stream from a coronal hole, most likely CH56/+. The wind speed was initially ambient near 350 km/s, but rose steadily until 20/0200 UTC and has been varying between 480-530 km/s since. The density was steady near or just above average until 19/2130 UTC when it rose to reach a peak of 32 ppcc, before falling to reach average levels again around 20/0430 UTC. The total magnetic field strength (IMF) Bt, was moderate between 8-12 nT, but fell back to weak after 20/0200 UTC. Bz was initially mainly southward directed, between +6/-11 nT, but became more northward directed after the phi angle switched from negative to positive around 20/0200 UTC, varying between +8/-3 nT. Geomagnetic activity was Quiet to Active (Kp 1-4), with a G1/Minor Storm (Kp 5) interval 20/0000-0300 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10MeV) measured at GOES 16 has tracked slightly above background levels after a very large and energetic flare and CME from the far sided eastern solar hemisphere on 15 February. The high energy electron flux (greater than 2MeV) has been at background levels. The corresponding 24-hour integrated electron fluence dropped sharply at the start of the period and is now steady well below the Active (1e8 integrated pfu) threshold. The 20/0000 UTC observation was 1.58e6 pfu

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is likely to be Low or Very Low at first, but with a slight chance of rising to Moderate due to the potential for flaring from one or more region (s) just starting to rotate onto the NE limb. The other three sunspot regions on the Earth-facing disc are currently unlikely to produce significant flares.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Earth is experiencing a high speed stream most likely from CH56/+, with this expected to persist for 24-48 hours before gradually easing. Geomagnetic activity is expected to be Quiet to Active at first, with a chance of further G1/Minor Storm intervals. This is expected to steadily reduce through the next 24-48 hours, with mainly Quiet activity expected by Day 4 (23 Feb).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is

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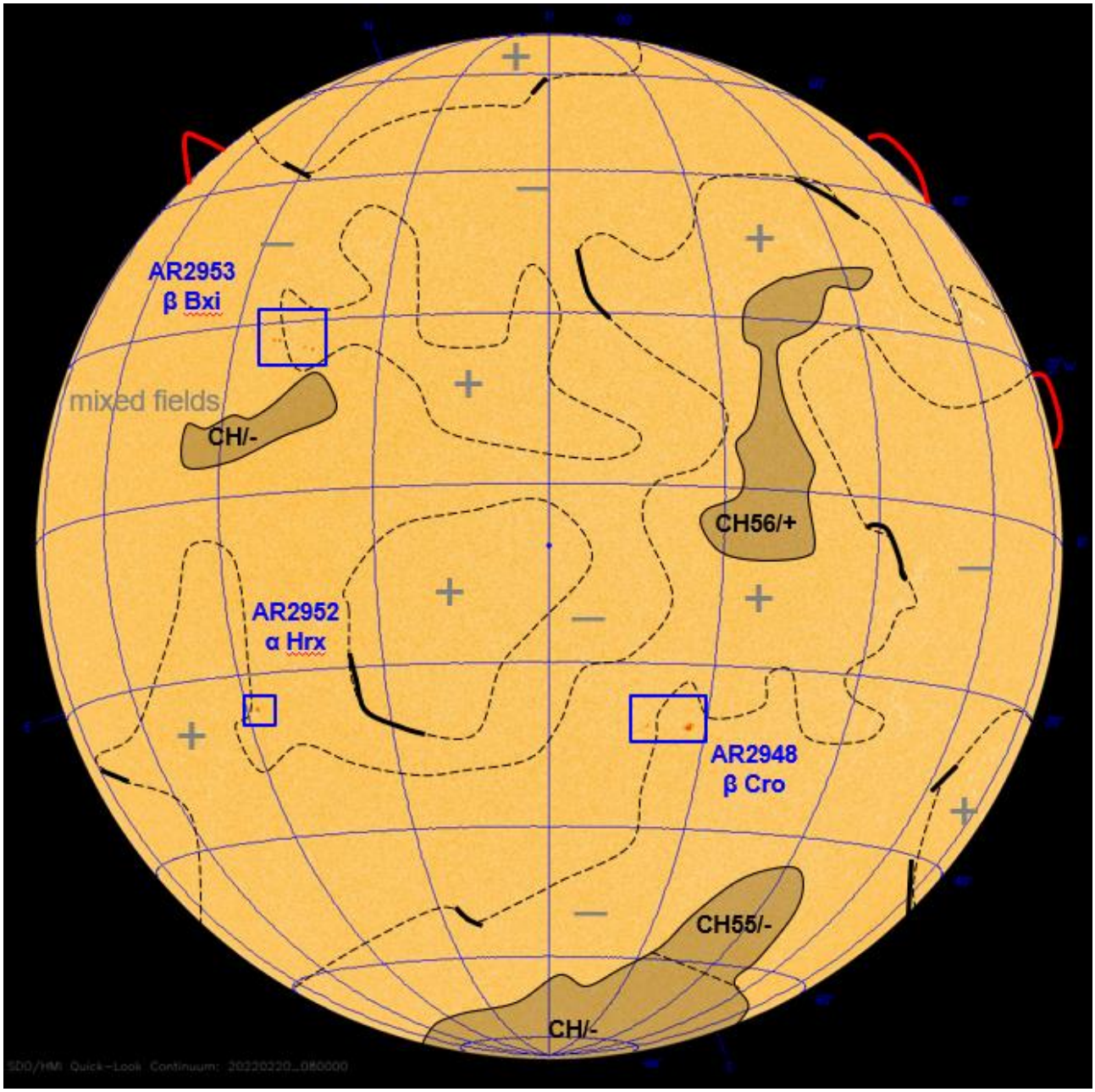
expected to soon fall to background levels and then persist at these levels. The high energy (greater than 2 Mev) electron flux is currently at background, but may increase from Day 2 (21 Feb) onwards, becoming Moderate with a chance of peaking at High (greater than 1000 pfu) levels. The associated fluence may also rise as a result, with a chance of reaching the Active threshold (1e8 integrated pfu), most likely on Days 3 and 4 (22-23 Feb).

Figure 1. Solar Analysis Valid 20/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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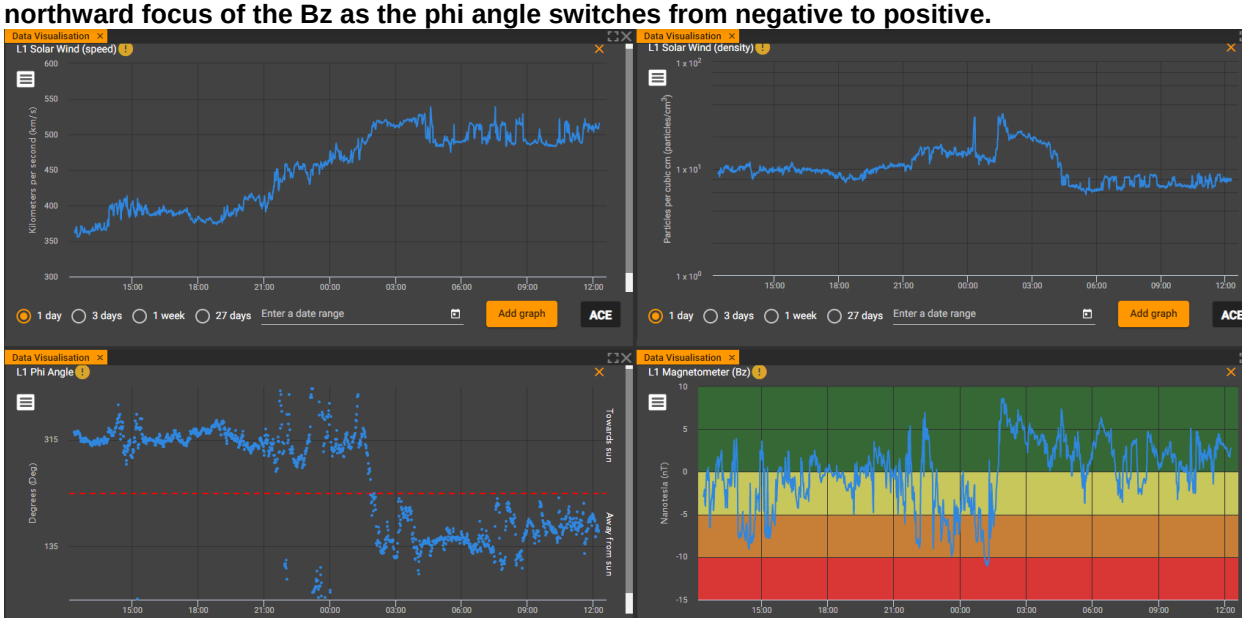
Geomagnetic Storms:
There are no Earth-directed CMEs.
Solar wind speeds are currently elevated, likely due to an early arrival of the high speed stream from a central disc coronal hole, CH56/+. It was initially thought that CH55/- would arrive first, followed by CH56/+, however the now positive phi angle suggests we have connected early to CH56/+. The G1/Minor Storm interval that occurred earlier in the UTC day happened in a negative phase, before the phi angle switched to positive. However, another switch to negative if we are brushing the edge of the two high speed streams can't be ruled out. Given that positive polarity coronal holes are less favoured at this time of year for geomagnetic response, it seems likely that the risk of further G1 intervals has now reduced somewhat. Elevated wind speeds are expected to continue through the next 24-48 hours, before a steady decline to background levels.

Consequently, geomagnetic activity is expected to be Quiet to Active at first, with a chance of further G1/Minor Storm intervals. This is expected to steadily reduce through the next 24-48 hours, with mainly Quiet activity expected by Day 4 (23 Feb).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	Yes	30	20	5	1
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Figure 2: Data from DSCOVR at L1, showing the high speed stream arrival and the change to northward focus of the Bz as the phi angle switches from negative to positive.



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Radio Blackouts - X-Ray Flares:
There are only three small and simple sunspots on the disc, however a new region is currently rotating onto the NE limb. Activity has been Low, with 2 C-flares from over the NE limb. AR2948 (Cro/Beta) in the SW quadrant has been decaying and is currently largely inactive. AR2952 in the southeast is a stable, but very small Hrx/Alpha spot. AR2953 (Bxi/Beta) in the northeast was showing some intermediate spots, but these are now starting to decay.

Magnetic looping is also visible on the northeast limb in SDO imagery, associated with one or more active region(s) just starting to rotate onto the disc, and will continue to do so during the coming 24-48 hours. This is a notably bright area on STEREO-A euvi, and potentially corresponds to the source of an energetic flare and CME on the far side on the 15th. This also corresponds to a large and strong helioseismic signal on far-side imagery. Furthermore, this signal is not expected on the limb until the 21st, suggesting the main risk may be from a second region following the looping that is visible on SDO. Either way, flares from just over the limb have the potential to be observed at Earth, giving a slight chance of M-flares and activity increasing to Moderate.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	2	2	2	2

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Figure 3: STEREO-A EUVI imagery showing a bright area rotating onto the NE limb. This was potentially responsible for a large far sided flare and CME.

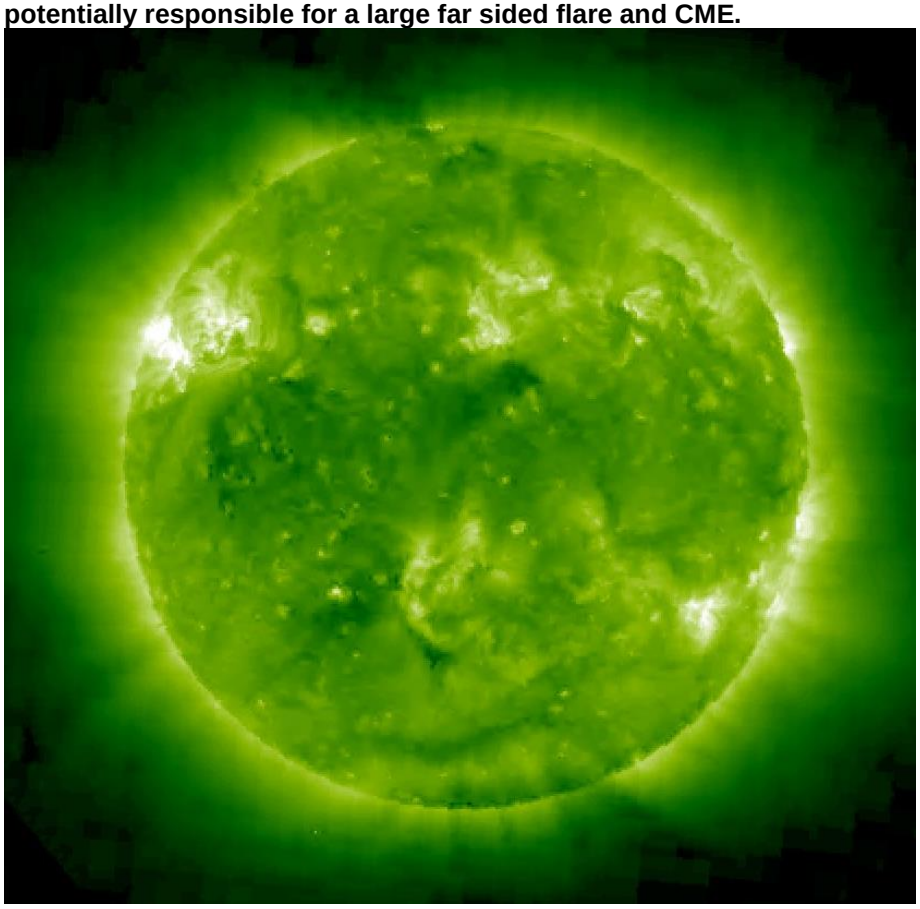
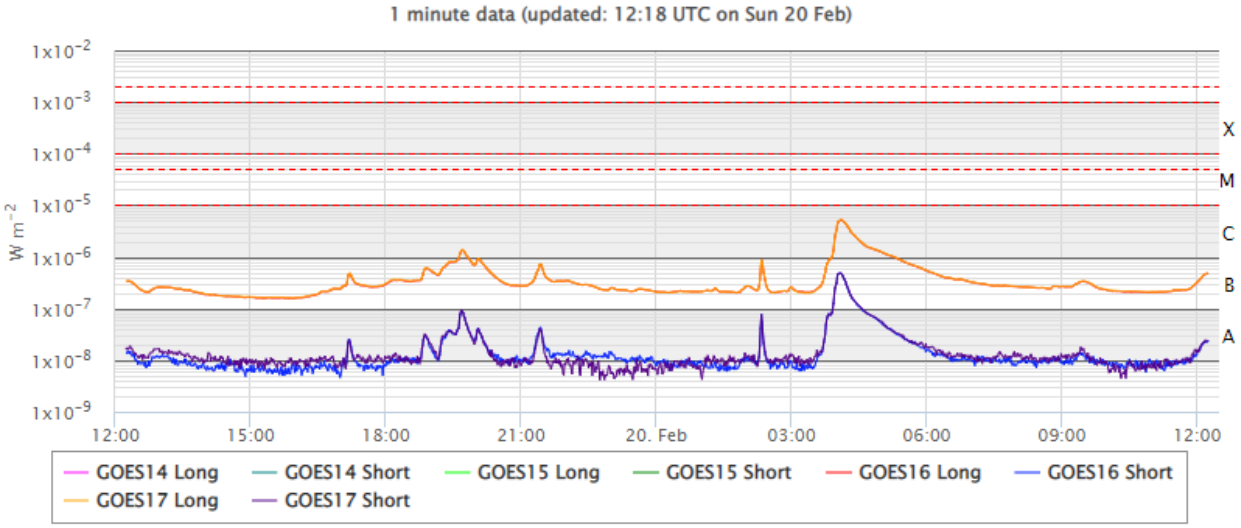


Figure 4: Two C-flares in the last 24 hours from over the NE limb.



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (10MeV) measured at GOES 16 has tracked slightly above background levels since 18/1200UTC. The enhanced activity was due to a very large and energetic flare and CME seen on coronagraph imagery from the rearward eastern solar hemisphere on the 15th. This region is due to rotate onto the Earth-side disc on the 21st, but has not exhibited any further significant activity since this flare. Furthermore, energetic protons are largely guided along the Parker spiral, and consequently radiation storms are notably less likely from the eastern limb for all except the largest flares. Until we can fully assess an ongoing flare risk from this region, the chance of proton storms (S1, which is greater than 10pfu) is maintained at background.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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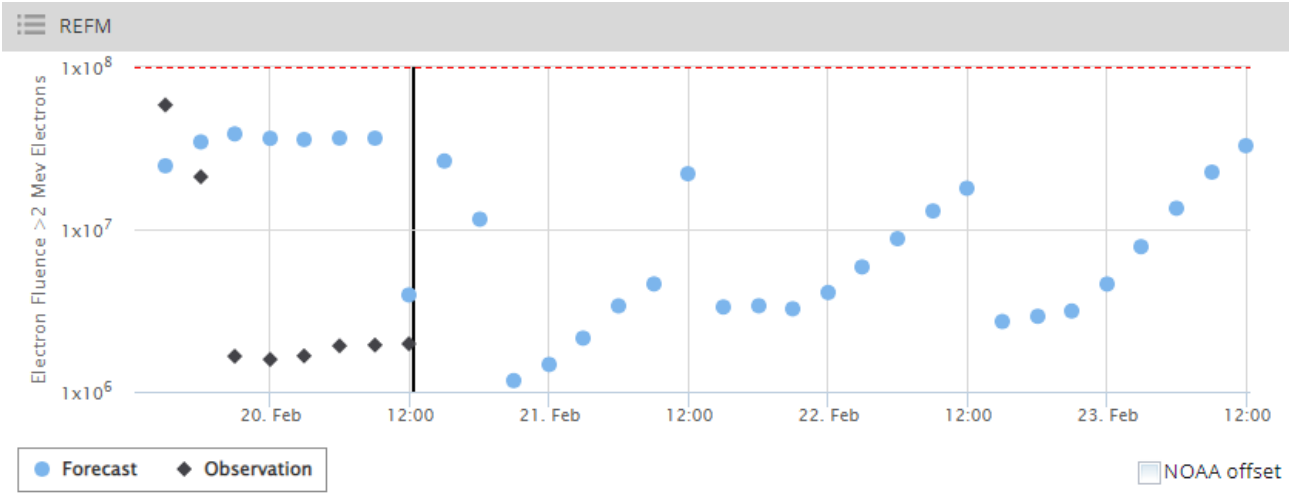
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2 MeV) as observed by GOES-16 at GEO is currently at background, having dropped out on the 19th. With solar winds now having risen to near elevated levels due to a recent coronal hole fast wind arrival, renewed electron charging is certainly possible. Electron flux may rise in the coming days, perhaps peaking at High (greater than 1000 pfu) from Day 2 (21 Feb) onwards. On Days 3 and 4 (22-23 Feb), more persistently Moderate to potentially High flux is possible.

The associated 24 hour Fluence is currently well below the Active threshold, but may rise from Day 2 onwards, with a chance of reaching the Active threshold, most likely on Days 3 or 4. REFM is now showing a rise in electron fluence as it starts to assimilate the arrival of the faster wind, although it is currently peaking below the Active level. This seems a reasonable trend, with lower confidence in the peak levels.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	20	30	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: REFM forecasting an increase in fluence, which is a reasonable trend.



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